

Research Article

Strategy of Overcoming for Educational Robotics Training for Teachers of Computing

Yamirka Mora Clavel^{1,*} , Rosalina Soler Rodriguez² ,
Rosa Lidia Martinez Cabrales³ 

¹Technical and Professional Education, General Directorate of Education, Santiago, Cuba

²Computerization Department, University of Oriente, Santiago, Cuba

³Computer Science Department, University of Oriente, Santiago, Cuba

Abstract

The national education system in Cuba is immersed in a necessary third improvement, which establishes among its objectives the gradual introduction of educational robotics, the development of computational thinking skills and the insertion of visual programming languages, such as Scratch, in order to achieve an educational process contextualized to digital technological development, which requires a coherent preparation of the computer science teacher, who does not feel capable of assuming the application of disruptive technologies such as robotics to the pedagogical process managed by this professional. The objective of this study is to assess the pedagogical effectiveness of the overcoming strategy, for the training of computer science teachers in educational robotics. Theoretical and empirical research methods were used: analysis synthesis, to characterize the overcoming process, observation of pedagogical practice and the survey to see the main needs for professional updating and the criteria of users to verify the opinions of computer science teachers as beneficiaries of the proposal. The structuralfunctional systemic method in the development of the overcoming strategy. The results show the effectiveness of the overcoming strategy reflected in the learning of robotic technology and in the creation of robotic prototypes. The improvement of the professional performance modes of the computer science teacher is also appreciated.

Keywords

Educational Robotics, Computer Science Teacher, Professional Development, Virtual Education

1. Introduction

The 2030 Agenda for Sustainable Development, adopted by the United Nations, in its objective 4 “Quality education”, recognizes the expansion of Information and Communication Technologies and global interconnection as great possibilities to accelerate human progress, overcome the digital divide and develop information and knowledge societies [1].

Cuba intends to meet this objective by adopting newprecepts that lead it towards the digital transformation outlined in the programmatic document, Digital Agenda 2030. Which recognizes that digital transformation is an evolutionary process superior to computerization, a cultural change, associated with the substantive use of digital

*Corresponding author: yam22640882@gmail.com (Yamirka Mora Clavel)

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technologies in all aspects of society, which changes the ways of thinking, doing, planning and which puts both natives and digital immigrants at the center, as an active co-creator and prosumer entity to promote the role of science, technology and innovation in the Cuban development model.

In addition, it is important to highlight that digital transformation has allowed the introduction of disruptive technologies into education, such as robotics, which contributes to the efficient and optimal development of educational processes, emphasizing the preparation of subjects capable of applying these technologies to the development of society. In all of this, the training of teachers specialized in their pedagogical use plays a fundamental role, so that they are considered more involved in these necessary transformations.

The aspects described force us to think about the bases on which teacher training should be designed to meet the demands of the third improvement of the National Education System in Cuba, which has been revolutionized since 2014, with a new curricular conception that carries out transformations in the study plans of all disciplines of the school curriculum, at all educational levels. In order to achieve an educational process contextualized to digital technological development, based on what was designed by the Central Institute of Pedagogical Sciences, in its conceptual bases of the third improvement [2]. To this end, it establishes among its objectives the gradual introduction of educational robotics, to enhance the development of computational thinking skills and to insert visual programming languages, such as Scratch. This is a significant challenge for computer science teachers who do not feel prepared to assume the application of disruptive technologies such as robotics in the pedagogical process managed by this computer science professional. This is a significant challenge for computer science teachers who do not feel prepared to assume the application of disruptive technologies such as robotics in the pedagogical process managed by this computer science professional. This allows this author to direct the present work to evaluate the pedagogical effectiveness of the overcoming strategy for training in educational robotics the Computer Science teacher.

Different methods were used for the development of the research. A classified study was conducted as descriptive. Within the theoretical methods, analysis synthesis were used to characterize the professional development process for training in robotics educational for the computer science teacher contained in articles published between 2018 and 2024; also to process the diagnostic data and prepare this article.

The systemic-structural-functional in the conception of the overcoming strategy. The empirical methods, observation, survey and user criteria to verify the opinions of the Computer Science teachers being the direct beneficiaries of the proposal and are otherwise responsible for the application

of the strategy.

The research was developed with computer science teachers from the Santiago de Cuba municipality, the identified population is made up of 33 computer science specialist teachers from lower secondary education, a sample of 13 computer science teachers was taken.

2. Theoretical Foundations of the Overcoming Strategy for Training in Educational Robotics for Computer Science Teachers

The concept of strategy in its most general sense means a path or way to achieve a purpose. As a research contribution, strategy has been valued by authors such as [3, 4]. They agree that it is the result of a process that is established to achieve an end, which ranges from the most rudimentary tools to the most professional ones depending on the scenario in which it is used.

The definition of a professional overcoming strategy has been systematized by several authors, who take as a reference the criteria of [5], which states that a development strategy is a system of personalized actions, which allow the implementation in pedagogical practice, the use of methods and procedures that enable the transformation of the subjects' behavior, seen in the performance of those who participate, leading them to overcoming and the elevation of the quality of life of human beings who develop in a given sociocultural context.

This research proposes a professional overcoming strategy for training in educational robotics for the computer science teacher, assuming the postulates of [5]. It is characterized by the close relationship established between the different stages that structure it, which accounts for its systemic and developmental nature. It is aimed at guiding and leading this process towards qualitatively higher levels and can be perfected, enriched and vary its applicability according to social influences and the subjects that participate in the training process. The strategy is based on Theoretical, psychological, pedagogical and technological foundations that support the preparation of this teacher, from a technical-methodological perspective, for the implementation of educational robotics as a learning object and teaching resource.

From a psychological perspective, the constructivist theory of knowledge is analyzed to understand thegnoseological processes that occur in the professional development of teachers. Emphasis is placed on the psychological characteristics of the adult development stage to recognize the contradictions that may arise in their learning. It is also based on the relationship established between cognitive development and the social environment, where computer science teachers are the protagonists of their own development and self-improvement, for better

professional performance and to raise the quality of education.

Another element that is taken into account are the ideas of [6, 7] who conceptualize the process of improvement for education professionals from different positions. They insist on knowing how to perfect the pedagogical process, the teaching-learning process of the various disciplines, the training in human values, as well as the insertion of educational technology in its evolution and development, all of which leads to professionalizing the pedagogical sciences.

It is assumed from [8] the categories of Pedagogy in the design of professional improvement for training in educational robotics for computer science teachers. Seeing training as a process and result, whose function is to prepare the subject culturally under the maxim that an educated man can solve the problems of his daily activity. Thus, conceiving training in educational robotics from the principles of constructivist and meaningful learning of active pedagogy.

As technological foundations, the references of digital competence proposed by [9] are assumed, as digital teaching competence the set of skills, abilities, knowledge and attitudes related to Information and Communication Technologies (ICT), which involve technological aspects (knowledge about the functioning of ICT and choosing the appropriate tool), communicative (referring to the knowledge and skills to identify, locate, retrieve, store, organize and analyze digital information) and didactic (the use and possibilities of designing resources and learning environments in education using ICT).

Another reference is the virtual education modality that is applied to professional development. Taking into account [10] who address the virtualization of this process with an emphasis on educational technology topics. For which the b-learning, i-learning, flipped classroom methodologies are taken, among others, which contribute to the forms of organization from the Moodle educational digital platform. The TPACK model [11], cited by [12] which consists of the knowledge that the teacher must possess to integrate Information and Communication Technologies, disciplinary, pedagogical and technological knowledge, considered in this research a solid basis for training in educational robotics for Computer Science teachers, from professional development.

The strategy of overcoming for training in educational robotics for Computer Science teachers has an objective character because it is based on the knowledge that Computer Science teachers have about educational robotics technology, so the diagnosis and characterization of these are necessary to achieve the proposed objectives. It also has a multidisciplinary and significant character in recognizing the use in professional development of a wide variety of learning environments: physical, virtual, hybrid, formal and informal, through productive and creative activity throughout the process, which promote quality learning and a taste for educational robotics technology.

Educational robotics is a subdiscipline of robotics. It

emerged in the mid-1990s, but it was not until 2000 that it was established as an educational tool. The development of ICT applied to education has allowed for a novel teaching system with robotics. Its use in education has been a topic addressed by several authors such as: [13-15], who characterize it taking into account motivation, the interaction of the robot with students and teachers, the roles that robots play, the role of robotics in the teaching and learning process and its connection with virtual platforms or robotics simulators.

This educational technology is a motivating option that surpasses traditional pedagogical processes and the teacher's stagnant thinking. It enhances logical and algorithmic thinking, fosters creativity and encourages educational innovation to transform its practices through robotic technology. The impact of the aforementioned pedagogical advantages has led countries such as the United States, Japan, Argentina, Spain and China to achieve significant results in the inclusion of robotics in pedagogy. They are precise in their scientific experiences regarding the need for teacher training.

The strategy of overcoming is structured into a diagnosis, a general objective of the strategy, premises, requirements and three stages: the first stage of planning, the second stage of execution and the third stage of evaluation, each with its specific objectives and actions, culminating in the evaluation of the strategy. The stages were conceived in an orderly, coherent manner, with a systemic structure and interrelation between them. At the end of each stage, an evaluation of the fulfillment of the proposed actions, their results and a redesign of the same must be carried out to complete them in the next stage.

The general objective of the strategy is to guide the actions to structure, execute and evaluate professional development, which favors the preparation of the computer science teacher in educational robotics. Therefore, to fulfill this objective, the influences that determine the premises and requirements necessary for the conception, execution and evaluation of the strategy must be comprehensively analyzed.

The premises constitute the favorable and unfavorable conditions that determine the conception and implementation of the strategy, as well as the requirements, which are those conditions that must be imposed for it to develop successfully.

3. Strategy of Overcoming for Training in Educational Robotics According to the Stages

STAGE I – Planning

Objective: To characterize the initial state of professional development based on the affective-motivational and cognitive conditions of the Computer science teacher. This stage begins with the diagnosis of the Computer science

teacher. The Moodle survey activity was used to identify the weaknesses and potentialities, the level of theoretical and practical knowledge that these specialists have in relation to educational robotics and the professional problems that hinder the pedagogical insertion of this educational technology. The causes that originate the problems detected, to define the improvement actions to undertake, which allows for adequate planning of the professional development process with a preventive and integrative character.

Action #1: Awareness workshop

Methodological procedures for the development of the workshop: It is developed through a meeting on Google Meet.

Start: Personal presentation of the participants referring to data of interest such as name, workplace, expectations of improvement. Observation of an educational video capsule referring to robotics to raise motivation and introduce the topic, communicating the objective of the workshop.

Development: The development manager explains to the computer science teachers the structure of the training process they are going to receive. He presents a digital infographic that invites a dialogue on educational robotics through reflections that he must propose to the computer science teachers in order to get to know their opinions.

Dialogue is used as the main means of effective and assertive communication, using the mechanism of persuasion to convince teachers of the need to update themselves in educational robotics and to activate their motivation towards new professional learning. A climate of trust and exchange of ideas is promoted so that participants can discuss their main concerns and receive convincing responses with empathy. At the end of the workshop, a participatory technique called "Pass the ball" is used where participants will reveal what they have learned in the workshop. All of the above favors the preconditions for the next action.

Action #2 : Training planning through the design of the Instructional model, using the ADDIE model.

This action is based on the results achieved in the diagnosis, allowing the training manager to define the design of the training in educational robotics, declaring training as the form of organization to be used, as it is an eminently practical type of training. The training modality is semi-presential (b-learning) using face-to-face and distance meetings through the Moodle platform, with a virtual classroom to create the training.

The overcoming manager configures the training in educational robotics through the different activities and resources of the Moodle platform: forum, chat, questionnaires, tasks, wiki and others, promoting significant and autonomous cultural knowledge in Computer science teachers. The training planning is adjusted to the analysis and reflection of what the computer science teacher should know and be able to do, with emphasis on the development of computational thinking skills from visual programming with the Scratch tool and innovation with robotics educational, through different

theoretical-practical activities to achieve technical-methodological preparation in the teacher that allows them to use this technology as a learning object and teaching resource.

I STAGE - Execution

In this stage, the actions conceived in the previous stage of the strategy are implemented and developed.

Action #3: Training development

Training title: "Training in educational robotics"

Course teacher: M.Sc. Yamirka Mora Clavel

Total hours: 30 hours Total credits: 3 Credits

Modality: semi-presential

Educational digital platform: Moodle

Duration: 2 months, 2 monthly frequency with a synchronous meeting of 3 hours through the interactive digital platform Jitsi Meet and the educational platform Moodle. Asynchronous activities are carried out within 15 days thereafter.

OBJECTIVE OF THE TRAINING: Design the learning activities of the training on the Moodle platform through learning activities and teaching resources for the training in educational robotics of the Computer Science teacher. They are organized into activities in contact with the teacher, such as the forum, autonomous learning activities, for example questionnaires, and experimental practical learning activities, which are tasks. The learning content is distributed in four themes. These promote the knowledge (conceptual), know-how (procedural) and being (attitudinal) of the computer science teacher.

TOPICS AND LEARNING CONTENTS

TOPIC 1: Basic notions of educational robotics. Origin and development of educational robotics. Concepts of educational robotics. General characteristics. Pedagogical advantages and limitations of robotic technology. Application of educational robotics as a learning object and teaching resource. Importance of training in educational robotics.

TOPIC 2: Programming in the Scratch language and computational thinking Interactivity with Scratch. Scenarios and characters. Building blocks (Character movements, Appearance, Sound, Pencil, Data, Events). Control, Sensors, Operators and More blocks. Basic concepts and procedures.

TOPIC 3. Interaction with an educational robotics kit. Definitions of robotics kit Basic components of a robotics kit and interaction with it. Types of educational robotics kit. Use of artificial intelligence tools for the development of educational robotics.

TOPIC 4. Methodology for teaching educational robotics. Use of technological tools and pedagogical techniques to teach robotics, design of activities that promote technical and transversal skills in students, connect robotics with other areas of the curriculum through the creation of interdisciplinary projects, creation of educational projects using project-based learning (PBL).

EVALUATION SYSTEM: Systematic through question-

naire, forum and task in the digital learning environment. Each topic will culminate with an experimental practical learning task. The final evaluation will consist of the development of a didactic project where a given situation is solved applied to educational robotics. Practical activities will be developed in person where the improvement manager, in coordination with the instructors of the Computing and Electronics Palace, will teach the Computer science teacher how to assemble and disassemble a robotics kit, the programming of a robot with a visual programming language using an Arduino board and the design and construction of a robot using recycled materials.

The training applies the conditions of strategy the overcoming in terms of the responsibility of the student to develop the hours of independent learning through self-preparation.

Action #4: Socialization workshop

A socialization workshop is held based on the experiences of the computer science teacher who participate in the training as part of the overcoming strategy. It is carried out virtually using the Google meet communication tool. Its objective is to socialize partial results of the training in educational robotics that is being developed in overcoming. It is a space and a mechanism for formative feedback in the process of overcoming to share, demonstrate and interact between the subjects who are improving and the manager.

The workshop will allow for the reformulation of elements that require it in order to improve the professionalization of the computer science teacher in educational robotics.

III STAGE:- Evaluation

This stage aims to verify the pedagogical modes of action acquired by the Computer Science teacher in the use of educational robotics as an object of study and teaching resource. Once the training is completed, the pedagogical validity of the professional development strategy for training in educational robotics is verified. informatics teacher's message.

4. Discussion

To assess the results of the strategy, the following was applied: the empirical method, user criteria, carried out through a survey. This technique allows obtaining the opinions of the subjects who become direct beneficiaries of a proposal, who are also responsible for the application of its results; they are not necessarily specialists in a subject, masters or doctors with a scientific level, but they are equally important, because they are the consumers of the proposed product. Although it leads to obtaining a subjective assessment, it is also direct on the final scientific result, as expressed by [16].

The survey was developed through the virtual classroom training activity. The results show that the 13 users surveyed agree in evaluating the impact of the content learned about educational robotics as excellent, which is evident in their

acquired knowledge, skills and human values. Regarding the applicability of learning about educational robotics to their teaching activity as a computer science teacher, the majority, 10 teachers (76.9%) evaluate it as good, they feel capable of reverting this knowledge to their students. In the case of the other computer science teachers, their preparation must be deepened because they are not confident about applying this learning in their pedagogical work.

Regarding the fact that the strategy has provided them with a professional update, all agree in valuing this aspect as excellent. This indicates that it is consistent with the objectives of improvement. The quality of the virtual activities in the training received is valued between excellent (69.2%) and good (30.8%), data that coincide with the results of the motivation achieved by training in educational robotics.

5. Conclusions

The assessment of the pedagogical effectiveness of the overcoming strategy for training in educational robotics for the Computer Science teacher was carried out through the user criterion method. In this sense, it shows a better preparation of the Computer Science teachers to introduce this disruptive technology in the pedagogical process as a learning object and teaching resource. The level of interest and motivation of the user teachers was evident, rising during its execution and showing satisfaction as users of the practical contribution of the research, thus fulfilling the objective of the strategy.

Abbreviations

ICT	Information and Communication Technologies
ADDIE	Analysis, Design, Development, Implementation and Evaluation
PBL	Project Based Learning
TPACK	Technological Pedagogical Content Knowledge

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Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



Yamirka Mora Clavel, Bachelor's degree in Education specializing in Mathematics-Computing, she has a Master's Degree in Educational Sciences since 2007 and works in the General Directorate of Education of Santiago de Cuba.



Rosalina Soler Rodriguez, Graduated in Education. Primary Specialty. Master's Degree in Educational Research Methodology. Doctor of Pedagogical Sciences. Full Professor. Works in the Computerization Department of the University of Oriente, Santiago de Cuba.



Rosa Lidia Martinez Cabrales, Graduated in Primary education, Mathematics specialty. Doctor of Pedagogical Sciences. Professor. She is a professor at the University of Oriente, Santiago de Cuba.

Research Field

Yamirka Mora Clavel: Instructional design model for virtual training in educational robotics training, Systematization of educational robotics training for the computer science teacher, Conception of training in educational robotics for the Computer Science teacher from overcoming, Training in educational robotics for the Computer Science teacher through virtualized professional development, Educational Robotics in the training of Computer Science teachers, Virtual course for training in educational robotics for the computer science teacher.

Rosalina Soler Rodriguez: Virtualization of the professional development process through the Moodle LMS platform., Digital education ecosystem 4.0. An innovation proposal for university education, Audiovisual educational technology in the teacher training process, Training in educational robotics for the computer science teacher through virtualized professional development, Audiovisual education of basic secondary school adolescents, "Audiovisual Context". An m-learning application for teacher training, Audiovisual media and children.

Rosa Lidia Martinez Cabrales: Methodological guide for the use of digital tools in the teaching and learning of mathematics, Educational improvement: a new look at the didactic management of the pedagogical process, Infotechnological curricular strategy for the use of social networks in the training of educational professionals, Mobile learning in seventh grade students of basic secondary school, Conception of training in educational robotics for the computer science teacher from overcoming.